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Australian Academy of Science

The Review

Australia's continued prosperity and wellbeing depend on maintaining a well functioning natural environment, capable of providing the life-giving and life-affirming services upon which we depend: clean air and water; food, fibre and fuel; soil and nutrients for agriculture; and spiritual, aesthetic, educational and recreational values. However, Australia's environmental scientists, including Fellows of the Academy, have expressed ongoing concern that the present environment and its biodiversity are changing at a rapid rate, to the detriment of these services, and that urgent action is required to present this decline. There is serious concern that the major legislative instrument for preserving Australia's environment, *The Environment Protection and Biodiversity Conservation Act 1999*, is not sufficient to address declines in Australia's environmental resources and biodiversity.

The Australian Academy of Science welcomes the Samuels Review and expresses hope that reforms resulting from the Review will address long-standing issues with the operations of the Act to the social, economic, cultural and scientific benefit of the nation.

The Papers

In discussion with Professor Samuel in mid-December, it was suggested that the Academy compile advice on topics pertinent to the Review, relevant to the Academy's science expertise and important to the goal of improving the status of Australian species and ecosystems. Accordingly, the Academy offers to the Review six short papers that address key aspects of the operations of the Act. These papers have been developed by Fellows of the Academy and members of the scientific community. They provide advice to the Review on recommended reforms to ensure that Australia's scientific excellence is able to support and be supported by the operations of the EPBC Act.

Although the papers are presented separately, they are connected in informing revisions to the Act to improve resilience and status of species and ecosystems. Each of the operations of the Act should work together as mechanisms to engage the community in addressing the broad and cumulative impacts on the Australian environment and biodiversity. It is expected that the Act will remain a strong regulatory framework for protecting the environment and biodiversity, assuring that Australia complies with the international conventions that it is a signatory party to.

The papers are on the following topics:

- **Resilience to disaster:** The catastrophic 2019-20 bushfires provided grave insight into the vulnerability of Australia's natural resources to large-scale disturbances, well beyond the already substantial natural variability in our climate and ecosystems. There is increasing evidence that Australia's ecosystems and biodiversity are prone to more, and more frequent, disturbances, including large-scale disasters. By preparing Australia's ecosystems for these events under the auspices of the EPBC Act, we can both improve readiness before events and respond more effectively when they occur. A stronger, more holistic focus on ecological communities, Key Threatening Processes (KTPs), strategic assessments,

Indigenous knowledge and data quality and transparency, as described below, is a way to achieve these goals.

- **An Increased Focus on Ecological Communities:** Australia's ecosystems are made up of highly complex interactions of many species. By shifting focus under the EPBC Act to ecological communities, and by treating all threatened communities as genuine Matters of National Environmental Significance (MNES), we can address threats in a more strategic, effective and efficient manner, reversing environmental declines and abating key threats. There will also remain, however, a need to focus on individual threatened species where improved ecosystem protection does not fully meet the species' needs.
- **Key Threatening Processes (KTPs) and Threat Abatement Plans:** The current system of identifying KTPs and establishing Threat Abatement Plans has many gaps that lead to environmental threats of national significance not being addressed. We recommend establishing a cross-jurisdictional, multi-sector, science-led threat identification process, and implementing KTPs triggers for MNES in a similar vein to the 'water trigger'. This can establish a clearer, quicker, more efficient and more transparent system that uses scientific advice to deliver the best outcomes under the terms of the EPBC Act.
- **Strategic Assessment and Bioregional Planning:** Current assessment processes under the EPBC Act address applications on a project-by-project basis, meaning cumulative threats are neither identified nor prevented. By placing greater emphasis on the Strategic Assessment and Bioregional Planning provisions already in the Act, strategic and cross-jurisdictional actions will result in better environmental outcomes with reduced administrative burden.
- **Indigenous cultural conservation:** Indigenous knowledge and cultural systems are deeply rooted in biodiversity, but many culturally significant and ecological communities are in decline. By allowing the EPBC Act to address conservation of species of particular significance to Indigenous Australians and elevating cultural knowledge within assessments under the EPBC Act, we can leverage the evidence base for Indigenous community environmental management to improve both ecological and cultural outcomes.
- **Data, uncertainty and decisions:** Decisions made under the EPBC Act should be made with regard to the best possible data. However, decisions are often made with imperfect, imprecise and uncertain information. Improving environmental data systems, establishing data standards, considering a taxonomy of decision points under the Act and providing support and transparency around both data quality and decision-making can provide clarity and consistency, reduce the administrative burden and ensure high-quality, evidence-based decision-making. This will allow the delivery of better outcomes for the objectives of the Act.

The Academy supports the Review and is prepared to continue to provide expert science advice. The Academy believes the best environmental, cultural and social outcomes will come from a decision-making structure under the EPBC Act that is informed by the best available scientific evidence.

To discuss or clarify any aspect of this submission, or to arrange further consultations with the Academy and its Fellowship, please contact Dr Stuart Barrow at stuart.barrow@science.org.au or 02 6201 9464.

Resilience to Disasters

Opportunity

There is extensive evidence that Australia's ecosystems and biodiversity are increasingly prone to human-driven disturbances, often at higher frequency and larger spatial scale than the natural variability to which our ecosystems are adapted. For example, wildfires will become more frequent, widespread, severe and intense as a result of rapid climate change (Williams *et al.*, 2009; Cary *et al.*, 2012; Jones *et al.*, 2020). Such events represent disasters for our species and ecosystems.

The EPBC Act needs to enable rapid response to the strong effects that such disasters can have on ecosystems and biodiversity. This document identifies and outlines some key responses and strategies to improve ecosystem and biodiversity resilience and resistance (Bennett *et al.*, 2014) and better guide decision-making under the EPBC Act (such as more rapid, evidence-based listings of threatened fauna, flora, ecological communities as well as Red-listed ecosystems).

What can science offer?

Avoiding, where possible, multiple interacting disturbances that can undermine ecosystem integrity and maximise the capacity for rapid response

Many species and ecosystems are at risk because of multiple, interacting disturbances (Didham *et al.*, 2007; Foster *et al.*, 2016). Interactions between disturbances are often not recognised in the listing processes for threatened species, ecological communities or ecosystems. For example, arboreal marsupials in the wet forests of Victoria, including those listed under the EPBC Act, are declining rapidly as a result of: (1) repeated fire, (2) logging, (3) an interaction between fire and logging (salvage logging; Lindenmayer & Ough, 2006) and (4) an interaction between logging and fire (because young, logged, regenerated forests are more prone to high severity fire through an interaction chain; see Taylor et al., 2014). Similarly, mountain herb fields in South-Eastern Australia are threatened by a combination of fire and temperature increases that favour shrub establishment over herbs (Camac *et al.*, 2017). A non-terrestrial example is the Great Barrier Reef, affected by repeated coral bleaching events from global warming; resilience of this iconic system can be reduced by the cumulative heat stress itself or combined with sediment deposition, nutrient run-off and overfishing (Bessell-Browne *et al.*, 2017; Humanes *et al.*, 2017; Hughes *et al.*, 2019).

Guided by this knowledge, the EPBC Act should be reformed to better accommodate the impacts of disasters in assessments of the status of threatened species, ecological communities and ecosystems. This becomes particularly important following major natural disasters, especially in regard to: (1) listing assessment and determining the need for up-listing, perhaps through an appropriately resourced and rapid emergency listing process for species, ecological communities and critical habitats, (2) recommending additional management actions as soon as major disturbances have occurred following a rapid emergency listing (such as an intensification of feral animal control immediately after fires), (3) limiting the risks posed by additional disturbances in already-disturbed ecosystems (such as limiting post-fire logging in extensively burned environments) and (4) considering emerging threats that are likely to have major impacts on species and ecosystems (such as an increasing frequency and intensity of droughts, and other key threatening processes with cumulative impacts).

Additionally, the capacity of government to facilitate rapid environmental responses to natural disasters should be increased, such as the capacity to trigger rapid, post-disturbance assessments of the status of species and ecosystems. Models such as the National Environmental Science Program

(NESP) enable this to occur so that scientific and policy learning and response can be maximised following major natural disasters (Lindenmayer et al., 2010).

Pre-planning of responses to major natural disturbance

Many decisions soon after major disasters are made in a crisis management mode (Lindenmayer et al., 2008) and are not necessarily good, evidence-based decisions. This includes management of ecosystems and individual species of native plants and animals. These decisions can undermine previous good management actions. An example is the rapid decision to conduct post-fire (salvage) logging in protected areas. This can have long-lasting negative impacts on ecosystem integrity and on biodiversity, including on species listed under the EPBC Act. A better model is for governments to plan for environmental decisions after natural disasters well before events take place. This is critical in the context of the EPBC Act, as some species and ecosystems can shift from low risk to high risk very quickly following large-scale natural disasters. For example, pines such as the Tasmanian King Billy and pencil pines have small distributions and are highly susceptible to single large fire events. This eventuality should be prepared for, through provisions such as a legislated process for emergency listing of unlisted species, ecological communities and critical habitats that require immediate action. Pre-planning actions for natural and human-induced disasters may include strategies to establish a mosaic of protected areas and connecting corridors providing source populations and enabling connectivity for recolonisation after major natural and human-induced disasters (Bernhardt and Leslie, 2013; de Juan, Thrush and Hewitt, 2013; Smith *et al.*, 2016). This is described further in the subsequent papers discussing ecological communities and strategic assessments.

Maximising understanding of species, ecological communities and ecosystems through long-term monitoring and research

Australian science has knowledge and information systems to identify key ecological or genetic characteristics of species that make them more prone to impact from disasters, as was done very rapidly by an Expert Panel following the 2019-20 fires. Such predictions need to be field tested in the context of long-term monitoring data that is critical to the listing process for many species and communities under the EPBC Act. However, the capacity in Australia to gather these long-term datasets has been undermined in recent years (Lindenmayer et al, 2017). The suite of groups targeted by best practice monitoring needs to be expanded to include those currently poorly documented, such as invertebrates and many plant groups. The importance of long-term data is particularly important in the context of natural disasters because it is often the sequence of disturbances over time (such as fire regimes; *sensu* Keeley, 2009) that have the most profound effects on species. For example, long-term fire history (such as the number of past fires) is a significant driver of overall bird species richness in Booderee National Park in the Jervis Bay Territory (Lindenmayer et al., 2008). The best way to quantify such responses to repeated natural disasters is through long-term monitoring. Indeed, threatened species and threatened communities management and recovery is most successful when it is supported by long-term monitoring (Garnett *et al.*, 2018). For this reason, the EPBC Act should mandate information on how to conduct best practice monitoring in species recovery plans and conservation advice and ensure that robust monitoring it is closely tied to on-the-ground management actions when planning instruments are implemented (Lindenmayer et al., 2020). This approach has been highly effective in recovering threatened species under the US Endangered Species Act and is a model that should be followed in Australia (Wintle *et al.*, 2019). Given severe resource limitations, a practical approach would be for monitoring to occur when regional recovery plans are implemented.

It is also important for Australia to establish comprehensive long-term ecological monitoring of different ecosystems to boost capacity in threatened species and ecosystem management under the EPBC Act, including in response to natural disasters. This is essential for generating the kinds and quality of data needed to make robust scientific decisions around listing, recovery and management outlined in the *Data, uncertainty and decisions* paper.

Solutions

1. Include emergency listing triggers and processes in the EPBC Act.
2. Establish, through the EPBC Act, a legislated requirement for a natural disaster environmental response strategy, to be prepared in advance of (and executed during or immediately after) a crisis. This should include capacity for research translation, for example, be modelled on the current NESP.
3. Mandate robust monitoring of species recovery plans and conservation advice following disasters, ensuring on-the-ground management actions are closely integrated with this monitoring and allowing the effectiveness of management to be quantified.
4. Increase capacity for long-term coordinated ecological monitoring of different ecosystems and bioregions to boost capacity in threatened species management under the EPBC Act, including in response to natural disasters. This will aid in the collection of data on ecosystem recovery and improved evidence-bases for strategic assessments.

Outcomes

The combination of long-term monitoring, strategic planning and capacity for rapid response under a framework legislated in the EPBC Act will allow for significantly more effective responses to natural disasters, improve ecological resilience and help protect vulnerable species.

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An Increased Focus on Ecological Communities

Opportunity

The EPBC Act provides for the listing of threatened ecological communities— the native plants, animals and other organisms whose interactions make a unique habitat— among its other functions. However, threatened ecological communities listed as 'Vulnerable' are not afforded the same protections under the EPBC Act as Vulnerable species and are not treated as Matters of National Environmental Significance (MNES).

Managing and conserving ecological communities and the underpinning processes that shape them provides an effective and efficient way to sustain biodiversity and the benefits, including ecosystems services, that nature provides. Currently, ecological communities and processes that sustain or impact them (see *Key Threatening Processes* paper) are under-represented on EPBC Act listings relative to species. The Commonwealth's adoption of the Common Assessment Method (CAM) for ecological communities, supporting assessments using the CAM, and increasing and prioritising the assessment of ecological communities and associated recovery plans, will increase efficiency, effectiveness and certainty in biodiversity conservation. In addition, extending the coverage of MNES to include Vulnerable ecological communities, consistent with the existing provisions for threatened species, will allow Commonwealth action to protect ecological communities before they become endangered or critically endangered. Doing so will benefit a number of threatened species.

What can science offer?

Ecological communities are comprised of their living components (species and their interactions), the abiotic (i.e. non-living) environment, and the interactions within and between them (IUCN, 2017). An increased focus on ecological communities can capture whole assemblages of species and their interactions, including undescribed or poorly understood species. Common and widespread species are often critical for ecosystem function, and changes to such species are often overlooked when management focuses on only threatened species. An increased focus on ecological communities and the processes that sustain them can increase certainty in, and improve, land-use planning, management and threat abatement (Keith *et al.*, 2015). This more holistic approach will also be more effective in the context of strategic and regional planning (see below).

An increased focus on ecological communities should not replace a focus on threatened species, but instead provide a complementary approach to help identify the broad suite of threats and pathways to biodiversity loss. For example, while the Critically Endangered Southern Corroboree frog, threatened by chytridiomycosis, can be bred in captivity, its survival in the wild depends on healthy alpine peat bog ecosystems, with sphagnum, and intact hydrological dynamics (Scheele *et al.*, 2014; Foster and Scheele, 2019).

Currently in Australia, some states and the Commonwealth Government use their own protocols for listing ecological communities or ecosystems (Nicholson *et al.*, 2015). Although in principle governments have agreed to a CAM for ecological communities as well as species (using the IUCN global standard for both), at present only NSW and the ACT have opted in for ecological communities. As a result, an ecological community can be endangered in one jurisdiction but not even considered threatened in another, partly because several states do not have provisions for this in their legislation. This leads to inconsistencies and confusion and is inefficient due to the need for reassessment against differing criteria.

There is a substantial international push to assess ecosystems both globally and within Australia using the IUCN Red List of Ecosystems approach (Keith et al., 2015). For example, a current project is

assessing Australian alpine ecosystems through collaboration between universities, governments and non-government organisations, while a global assessment of all terrestrial ecosystems is underway. Other examples of such an approach have been published, such as that for the Mountain Ash forest ecosystem in the Central Highlands of Victoria (Burns *et al.*, 2015). Governments in Australia can capitalise on this work, using the resultant assessments to streamline EPBC Act listings using the best available science.

Solutions

1. Adopt the IUCN Red List of Ecosystems protocol as the CAM in the EPBC Act and encourage all state/territory governments to do the same.
2. Increase support for the assessment of ecological communities using the CAM.
3. Harmonise the categories and criteria for listing ecological communities with the IUCN categories and criteria to facilitate adoption across jurisdictions.
4. Extend MNES to include 'Vulnerable' ecological communities.
5. Increase assessment of ecological communities and development of recovery plans that consider the ecological processes that ensure ongoing viability of these communities.

Outcomes

If the Commonwealth and state/territory governments adopted the IUCN Red List of Ecosystems protocol as the CAM at all levels of government, listings of ecological communities will be consistent across jurisdictions. This will greatly increase efficiencies because it will allow the use of assessments from other jurisdictions and assessments undertaken outside government that use the global standard. This could occur through the Species Expert Assessment Plan — such as the Australian Alpine ecosystem assessment currently underway. In addition, having more ecological communities listed will provide greater certainty in listing, management and regulation, through an established map of ecological communities and outcomes-based recovery plans. Finally, a much larger proportion of Australia's unique biodiversity will be sustained through the combination of protecting threatened ecological communities and species, including capturing ecological and evolutionary processes and poorly known aspects of biodiversity.

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Key Threatening Processes and Threat Abatement Plans

Opportunity

Following the listing of a Key Threatening Process (KTP) under the current EPBC Act, the Minister for the Environment may make a Threat Abatement Plan (TAP), if such a plan could facilitate effective and efficient abatement of the threat.

Relying as it does on public nominations, the listing of KTPs is incomplete and not systematic. There is a need to include expert-identified threats, such as livestock overgrazing and changed hydrological regimes.

There are well recognised KTPs (for example, land clearing and the loss of habitat caused by anthropogenic emissions of greenhouse gases), which, although listed as KTPs for many years, have been perceived as 'too difficult to handle' through the KTP/TAP process, due to the cross-jurisdictional federal system or because they are subject to legislation and regulations other than the EPBC Act. At present, KTPs are best addressed when they fit into a 'sweet spot' of having technical solutions available and being solely or largely under Commonwealth jurisdiction. The Longlining KTP, as an example, falls under the aegis of Australian Fisheries Management Authority, a Commonwealth body. The Commonwealth often lacks the regulatory ability and policy influence to address KTPs under state and territory jurisdiction.

The emphasis also tends to be on immediate individual threats, with little capacity for proactive identification of interacting or emerging threats and thus on strategic abatement actions.

The current EPBC threat abatement process is slow, complex and time consuming. The listing process can take years as the listing of inappropriate fire regimes demonstrates; the mandated reviews can take a similar length of time. The constraints appear to be primarily resourcing for listing, abatement planning and reviewing of threats.

Resourcing for listing and preparation of TAPs is limited, and there is no statutory backing for enacting TAPs. For this reason, TAPs are often not implemented effectively. Resourcing is limited (even for the mandated five-year review), meaning that for most TAPs, reviews are well behind schedule or not reviewed at all.

In addition, monitoring of TAPs is severely limited, meaning that adaptive learning about the effectiveness of abatement processes and how to improve them is severely restricted.

Many threats interact. For example, fire kills many animals and removes vegetation cover that attracts introduced predators and facilitates hunting efficiency. Some threats will be most effectively mitigated if they are managed together, but there is currently no formal provision for a single TAP to address multiple threats.

Threat abatement needs to be guided by science, but it also needs to have political and community buy-in. Threat abatement planning needs to consider these dimensions. There must also be a more uniform approach to the listing of KTPs and development of TAPs that cross state boundaries and tenures.

The KTP identification process and the development of associated abatement plans— as planned and intended by the drafters of the EPBC Act— should assist in maximising our ability to efficiently conserve species and ecological communities. Evidence to date, as acknowledged in the *Discussion* paper, is that the present process is not effective. No TAP has yet fully contained or abated the threat it was designed to combat.

What can science offer?

A format where high level KTPs are treated as Matters of National Environmental Significance (MNES) under the Act would prioritise central, scientifically identified threats. The present scientific advisory process uses scientific processes with internationally validated methodology. An elevated listing level would empower the Commonwealth, states and territories to act on this advice to address threats that operate at a national scale.

Threat listing and abatement planning should be closely linked, with clear, documented processes for identifying threats and developing abatement plans. A national scientific workshop, hosted by the Academy, could be used to identify key threatening processes using the expertise of the Fellowship and the scientific community. This workshop would identify current KTPs to be legislated as triggers for MNES in a similar vein to the 'water trigger'. Crucially, this workshop would also develop criteria to prioritise threats under each KTP, identifying national-level threats to be addressed. These criteria would then be applied by the Threatened Species Scientific Committee (TSSC) in assessing future threats.

Following this workshop, there could be an annual call for public nominations of potential threats of national significance. Modifying the EPBC Act to allow multiple TAPs under a single KTP would allow a public process to identify threats, which would be prioritised by the TSSC according to the established criteria. Conversely, allowing TAPs to operate under multiple KTPs would allow TAPs to address broad-based threats. TAPs would then be addressed by a cross-jurisdictional and cross-sectoral process mandated under the Council of Australian Governments. Multiple TAPs would allow strategic abatement actions across a much broader range of threats than is currently possible.

Emergency protocols should also be established to address rapid-onset threats that require immediate abatement action.

With respect to the TAPs themselves, monitoring and evaluation must be built in. There must be a strong commitment to review scientific information on a regular basis and incorporate new knowledge, with a full review at least every five years. Present TSSC has the necessary expertise.

Efficiencies could be gained by delegating threat listing decisions from the Minister to the TSSC, where listing decisions are based on scientific processes using internationally accepted methodology.

Resourcing for the TSSC and the scientific assessment panels should support the development, execution and monitoring of TAPs and other advice prepared by the committees established under the EPBC Act. In particular, resourcing of TAPs should be commensurate with the national level threat that they are designed to address.

At each stage, every effort should be made to ensure engagement with all affected parties, to allow cross-jurisdictional and cross-sectoral issues to be appropriately considered

Solutions

1. Elevate high level KTPs to MNES.
2. Hold a national scientific workshop hosted by the Australian Academy of Science to identify current national-level threats and establish criteria for their prioritisation.
3. Modify the Act to allow multiple TAPs under a single KTP and for a regional TAP to address multiple threats, and to allow strategic planning for abatement actions.
4. Hold an annual call for public nominations for threats of national importance.

5. Speed up the process for listing, and consider an emergency listing procedure for rapid-onset threats that need quick action to be abated (such as the introduction of a novel plant pathogen that affects native vegetation).
6. Consider separating Australia-wide KTPs that affect many species or ecological communities as MNES as distinct from local KTPs that affect the minimum number of species to satisfy listing.
7. Ensure engagement of all stakeholders in the TAP, including members of any species-based recovery plans whose species are affected by the KTP and associated TAP.

Outcomes

The preferred outcome is a clearer, more efficient, more transparent system that uses scientific advice efficiently to identify and rank KTPs, with a clear, quick response system for developing and implementing TAPs.

Strategic Assessments and Bioregional Planning

Opportunity

As acknowledged in the *Review* discussion paper, there is abundant evidence that Australia's species and ecosystems are continuing to decline under the current implementation of the EPBC Act. As just one example, Ward et al. (2019) found that 7.7 million hectares of habitat for threatened species was cleared from 2000 to 2017, with 93% of clearing actions not referred for assessment. Just 1.3% of referrals were from the agriculture sector. This shows that reliance on individual project approvals is failing and biodiversity is subject to the 'death of a thousand cuts' syndrome. Conservation offsets, when implemented, are intended to result in no net loss of habitat— but this is in context of a baseline of ongoing decline; this mechanism is not designed to recover threatened species or ecosystems (Simmonds et al. 2019).

Given this ongoing challenge, many have called for a stronger focus on use of broader provisions, specifically Strategic Assessments (SAs) and Bioregional Planning (BP).

The Hawke 2009 review of the EPBC Act (Ch3) advocated strongly for enhancement and greater application of SAs and BP as a means to reduce administrative burden while

- improving cross-jurisdictional planning for conservation of listed species and ecosystems and for managing Key Threatening Processes
- reducing cumulative impacts on, or improving the status of, Matters of National Environment Significance (MNES)
- facilitating engagement with multiple stakeholders, including indigenous interests
- harmonising biodiversity protection with actions to mitigate climate change.

The Hawke review noted that the 2006 amendments to the Act improved provisions for SAs and BP and that the Council of Australian Governments supported their use, yet the uptake has been slow and piecemeal. This situation continues to the present, with the exception of use of BP for Commonwealth marine reserves.

Hawke's summary nine-point plan included the following measures:

> (4) streamline approvals through earlier engagement in planning processes and provide for more effective use and greater reliance on strategic assessments, bioregional planning and approvals bilateral agreements (detail in Recommendation 6);
>
> (5) set up an Environment Reparation Fund and national 'biobanking' scheme (detail in Recommendation 7).

From a different perspective, the recent Craik (2018) *Review on interactions between the EPBC Act and the agriculture sector* also strongly endorsed a shift from individual project proposals to proactive SAs and regional plans. Such regional plans would be essential to transparent operation of incentives such the proposed $1 billion National Biodiversity Conservation Trust, as a mechanism to support actions by farmers to protect and manage MNES. In response, the Commonwealth Government has committed $30 million to a pilot an Agricultural Stewardship Program and is trialling a Farm Biodiversity Certification Scheme.

Subsequently, the National Farmers Federation, in their 2019 *A Return on Nature* report, highlighted the potential for farmers to contribute strongly to improving conservation outcomes and ecosystem services— potentially a win-win for the farming sector and society. Like Craik, the National Farmers

Federation called for establishment of an ecosystem services market and financial incentives for farmers to engage.

Finally, many Indigenous communities and traditional owners are now actively returning to country to manage ecosystems and important cultural species and sites. This has bipartisan political support through funding of Indigenous Protected Areas and Indigenous Ranger groups.

All of this points to a convergence of interests of landholders (such as Catchment Management Authorities and Landcare groups) and Indigenous traditional owners in taking practical actions to improve biodiversity. To be effective, these activities should be done in the context of SAs and/or BP.

What can science offer?

Any expansion of SAs and BP, in place of individual project assessments, must be founded on high-quality and transparent information on the condition and distribution of MNES and changes in these. Approvals and investments should be set in the context of cumulative effects (positive or negative) on the status of MNES. Without SAs or BP agreements, and the tools for transparent verification, the requirement for assessments of individual projects should remain.

Australia has world-class informatics resources and analytics to enable provision of high-quality information. This includes vegetation mapping, remote sensing capabilities, detailed species distribution data (including capability for citizen science contributions) and conservation planning and assessment tools. These capabilities include national (NCRIS) investments such as the Terrestrial Ecosystems Research Network (TERN), Atlas of Living Australia, Digital Earth Australia (via Geosciences Australia) and the developing National Environmental Prediction System. There is also agreement across governments to capture data from environmental impact assessments and to integrate with other sources to develop a 'Shared Analytical Framework for the Environment' (WABSI, 2019).

Bioregional planning

The Interim Biogeographic Regionalisation for Australia (IBRA) is supported by all levels of government as the tool for regional planning, such as for assessing the representativeness of the National Reserve System. The 89 bioregions, and 419 subregions within them, are defined based on common climate, geology, landform, native vegetation and species information. As such, these are logical, science-based, spatial units for bioregional planning.

Conservation assessment and planning tools

Australian scientists have been at the forefront of developing concepts and tools for spatial conservation planning and have the experience and knowledge to develop robust systems for assessment and planning SAs and BP and for monitoring outcomes against agreed targets. This expertise, across academia, CSIRO and agencies could be readily deployed to enable SAs and Bioregional Plans to be implemented with confidence. In doing this, there would be need for strong engagement between researchers and end users (such as agencies, NGOs and landholders) to ensure that the tools and systems developed are fit for purpose.

Solutions

1. Expand use of SAs and BPs to reduce requirements for project-by-project assessments and approvals.

2. Establish cross-jurisdiction mechanisms for enacting SAs and BPs, with states having responsibility for implementation while the Commonwealth has oversight of auditing and ensuring compliance.
3. Establish rigorous methods for transparent assessment, planning and verification by responsible agencies, preferably independent from government.
4. Given the above, develop and resource ecosystem/biodiversity incentive mechanisms to engage landholders (including agriculture, Indigenous communities, etc.) in habitat restoration for MNES**.**
5. The next iteration of the Department of Agriculture, Water and the Environment National Environmental Science Program includes a Hub focused on 'resilient landscapes'. Within this, a cross-disciplinary program should focus on the socio-economic, policy and science issues that need to be solved to establish SAs and BPs as effective mechanisms for conserving and restoring Australian biodiversity.

Outcomes

By use of provisions already present in the EPBC Act, expanded use of SAs and BP will result in substantially better environmental outcomes with significantly reduced administrative burden, as noted in the Hawke review. It will allow better information and more clarity for agricultural industry, as per the Craik review, and provide mechanisms for farmers, landowners, traditional owners and other parties to participate in meaningful, effective conservation actions. By taking a strategic approach by bioregion and ensuring an integrated, cross-jurisdictional engagement with environmental issues, the 'death of a thousand cuts' problem identified by Ward et al. (2019) can be addressed.

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Conservation of Plant and Animal Species of Significance in Indigenous Culture

Opportunity

Indigenous Australians have a deep connection with biodiversity and value many plant and animal species differently from non-Indigenous Australians. High value is ascribed particularly to those plant and animal species that are totemic or important as traditional food or medicine. The viability and cultural strength and continuity of many Indigenous communities is dependent upon the maintenance of these species in their environment (Altman, 1987) . Many of these culturally significant species are in decline due to introduced pests and weeds, altered fire regimes, climate change and other factors. However, the EPBC Act does not currently provide any specific opportunity or mechanism to help conserve these species unless they are so imperiled that they qualify for listing as threatened, by which stage it may be too late to maintain the cultural resonance of these species.

In contrast, many species protected under the EPBC Act through listing as threatened have little or no significance to Indigenous culture.

The failure of the current Act to provide any mechanism to help conserve plant and animal species most highly valued by Indigenous Australians appears inconsistent with the Objects of the Act, which are:

- to recognise the role of Indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity; and
- to promote the use of Indigenous peoples' traditional knowledge of biodiversity with the involvement of, and in co-operation with, the owners of the knowledge (s. 3(1) f, g).

The current review of the Act represents an opportunity to redress this deficiency. It can do so by giving an explicit status to, and consequent protection and pathway to recovery of, plant and animal species of particular significance to Indigenous Australians.

There is one non-explicit catch-all mechanism currently available in the EPBC Act. Section 190 allows for the Threatened Species Scientific Committee to advise the Minister about concerns that species may be becoming threatened but that have not yet met the relevant eligibility criteria for formal listing as threatened. However, this section provides little consequential advantage to any such species (the Minister must simply 'have regard to any advice'). Moreover, this mechanism is inappropriate as this is cultural matter rather than a scientific one and should have different criteria to those internationally recognised criteria used for listing threatened species.

A more explicit and targeted mechanism, and one more likely to help conserve and recover such species, is for revision of the Act to explicitly add a new section on the conservation of entities (species, populations, ecological communities, ecosystems, stories, songlines) of particular significance and concern to Indigenous Australians as Matters of National Environmental Significance (MNES). As with threatened species and ecological communities, there would need to be a tailored and justified listing process for such species in regulation and a prescription for their protection and recovery. The process should specifically include relevant Indigenous communities in planning and recovery actions. The Indigenous Advisory Committee would be the appropriate Listing Authority for such an action, with advice as appropriate from the other relevant committees. It should be possible for a species/ecological community to be listed as both threatened and of cultural significance.

A potential complication with this recommendation is that, while the EPBC Act appropriately uses a national scale for the listing and conservation of threatened species, culturally significant species may be more readily defined and protected at local scale. In such cases, it may be arguable whether or not such culturally significant species should be considered as MNES or rather should be dealt with by state/territory jurisdictions. Of relevance to this argument is that existing state/territory legislation does not currently provide explicit protection for such species. Furthermore, international agreements indicate an obligation on the Australian government to conserve species of Indigenous concern. For example, the Convention on Biological Diversity's Aichi Target 18 states:

> 'By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.'

What can science offer?

Indigenous knowledge is a potent counterpoint and complementary knowledge stream to Western science. Collectively, these knowledge bases provide an opportunity to engage in conservation management ideally tailored to Australian environments (Altman, Buchanan and Larsen, 2007; Moritz *et al.*, 2013; Ens *et al.*, 2015). Both knowledge bases recognise widespread decline of many species, including many of cultural significance but not necessarily listed as threatened, across Indigenous lands (Burbidge *et al.*, 1988; Ziembicki, Woinarski and Mackey, 2013). In many Australian regions, Indigenous land and sea country managers are currently attempting to manage their culturally significant species (Altman, 2003), but such actions are not explicitly supported by governments unless the species or ecological communities are listed as threatened. There is a strong evidence base that environmental management by Indigenous communities provides multiple benefits, including for health, education and employment (Burgess *et al.*, 2009; Garnett *et al.*, 2009).

Solutions

1. Revise the Act to explicitly address conservation of species of particular significance and concern to Indigenous Australians, with a dedicated provision to include matters of entities of particular significance to Indigenous communities as MNES.
2. Establish cross-jurisdictional mechanisms to bridge local identification of declining culturally important species and other entities of cultural significance with national conservation instruments.
3. Develop and leverage the evidence base for Indigenous community environmental management by establishing a research centre for cultural land management that integrates with the broader National Environmental Science Program.

Outcomes

Revision of the Act to recognise and help protect and recover species and other entities of Indigenous cultural concern will lead to improved ecosystem management across Australia, particularly in remote regions. It will help maintain and strengthen Indigenous culture. It will allow for conservation interventions for declining biota before they become so imperiled that their management options are forlorn or unachievably expensive.

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Data, Uncertainty and Decisions

Opportunity

Decisions made under the EPBC Act (Table 1) require an evaluation of future risk to listed threatened species and ecological communities based on our current understanding of status and threats. Often knowledge is imperfect and predicted outcomes are therefore uncertain. However, uncertainty exists in all data, whether it be environmental, social or economic.

There are many potential issues with the use of data within the Act that can result in uncertainty. A lack of definition of key terms within the Act (i.e. 'significant impact') leads to uncertainty in decisions due to linguistic ambiguity. Data itself may not be accurate, precise (i.e. quality issues), and/or comprehensive (i.e. quantity issues), leading to uncertainty about the distribution or status of a listed entity, critical habitat or threatening process, or the impact of an action. This can be a feature of both empirical data and expert-derived data. Uncertainty in data can itself lead to a lack of confidence in decisions. This is compounded when data and associated modelling (including assumptions) are not transparent, accessible or available, such that it is hard or impossible to interpret findings to support decision-making.

Further complicating the decision-making process, there are invariably competing social and economic objectives that must be accounted for in decisions made under the Act which present trade-offs for decision-makers. One of the recommendations in the Hawke review was that 'the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making'. The government response was to reject this recommendation, suggesting there are many specific provisions in the Act 'that require a science-based decision on environmental considerations to be made before social and economic factors are considered'. However, the Act is failing in this regard. Why? Arguably, one of the reasons is that data and accompanying uncertainty are not being transparently represented or incorporated into decision-making processes, which leads to several problems:

i) We have little confidence that changes (such as declines) in species and ecological communities are able to be detected (Figure 1).
ii) Decisions on how to protect and recover threatened species and ecological communities may not lead to positive outcomes.
iii) Decision-makers are not able to make decisions that account for their tolerance to risk (i.e. accounting for worst- and best-case outcomes, see Figure 2).
iv) Due to the above, the precautionary principle is inconsistently applied (Figures 1 and 2), likely leading to ongoing biodiversity declines.

The response to the Hawke review indicated that the government was committed to improving transparency, accountability and efficiency under the Act. There remains an important opportunity to improve the use, transparency and accessibility of data both within the Act, and in decision-making that occurs within and as a result of the Act. Issues in the use of data in decision-making vary depending on the context (Listing, Planning, Implementation, Monitoring and Reporting (Table 1)), and we suggest that solutions need to account for these differences.

Table 1. A taxonomy of EPBC Act decisions and data-related issues

Decision category	Data-related issues
Listing	- A listing decision by the Minister based on best available data can be challenged and overturned by the parliament, rendering the precautionary principle obsolete - Quantitative evidence (data) is not required to justify the parliament overturning a decision
Planning - Referrals and Controlled actions	- No quantitative definition of significant impact (Figure 1) - No data standards available (i.e. data quality and uncertainty not specified) - No data record or consideration of cumulative impacts
- Environmental Impact Assessments (including Strategic Assessments)	- No data standards available (i.e. data quality and uncertainty not specified) - No quantitative minimum impact thresholds (accounting for tolerance for uncertainty) set for environmental objectives, such that environment can be set as a hard constraint prior to consideration of social and economic objectives - No decision-support tools to guide decisions, accounting for uncertainty and risk (Figure 2)
Implementation - Management Plans, Recovery Plans, Threat Abatement Plans, Wildlife Conservation Plans	- No guidance and limited use of structured decision-making protocols that account for environmental and social benefits, costs and feasibility of actions - Limited use of summarised and critically appraised scientific evidence to inform selection of best practice conservation interventions - Lack of guidance on how to incorporate different data sources in management planning
Monitoring and Reporting	- No monitoring standards (i.e. focus is currently on reporting implementation of actions and short-term outcomes, but there needs to be a regulated requirement to monitor long-term outcomes of biodiversity) - Minimal centralised data storage - No reporting standards (lack of transparency) - No provision (e.g. tools) to link monitoring data to subsequent listing, planning or implementation decisions (i.e. decision triggers; Figure 1) - No decision support tools to guide the use of data to improve decisions (i.e. adaptive management)

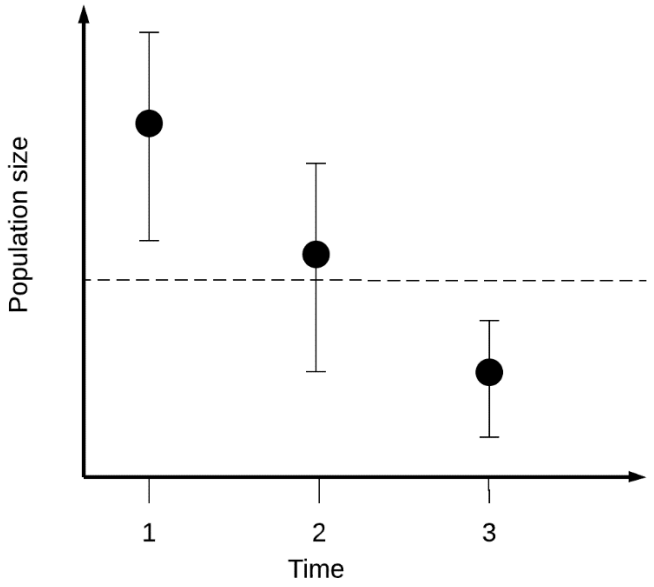

Figure 1. At time period 1 and 3, we are confident the population sits above and below (respectively) the dashed line. The average (noted as the black circles) indicates the population sits above the threshold at time 2, but this cannot be assumed if we account for uncertainty. This dashed line could represent two scenarios: 1) monitoring to detect a threshold for the population in terms of listing status (i.e. endangered to critically endangered). At time 2, the Precautionary Principle could be enacted and the species status is changed to critically endangered, until further sampling has occurred; 2) the threshold could also represent a 'significant impact' for a species, and as such represents a decision trigger for a development proposal. The proposal will proceed if the population size sits above the dashed line. Highlighting uncertainty (as part of a data standard) triggers the need for further sampling to detect whether the development goes ahead or not.

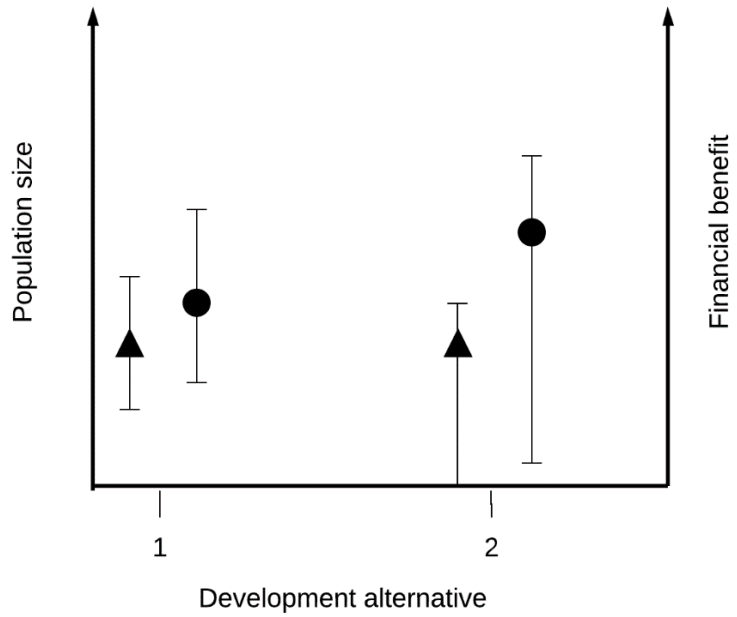

Figure 2. The outcomes for two development proposals are indicated for a threatened species population size (triangles), and financial benefit (circles). If we look at the average only (the shapes) we would choose development alternative 2 because it has a higher potential financial benefit, but the average population size for the threatened species is the same across alternatives. However, accounting for uncertainty, alternative 2 indicates the threatened species could be lost (i.e. lower bound = 0), and the financial benefits are highly uncertain. In a data standard regulated under the Act, if we are explicit about uncertainty we can adopt a risk-averse attitude and assume the worst-case scenario (i.e. the species is being impacted) until further data is available. This is quantitatively adopting the Precautionary Principle.

What can science offer?

We are fortunate in Australia to have a strong background in environmental decision science and substantial investment and development of critical information systems. In particular, there are three fields of research that could be used to improve the implementation of the EPBC Act.

- *Collection, analysis and storage of data*: Fundamental and applied research on the ecology, threats, management, recovery interventions and impacts of development on the threatened species and ecological communities is essential to understand how to effectively deliver the EPBC Act objectives. Scientific data provides a reliable guide to evaluating likely outcomes (including uncertainty) in the context of environmental risk assessments and recovery planning. Scientific data are integral in evaluating and justifying planning decisions (such as Environmental Impact Assessments and identifying controlled actions), monitoring outcomes (recovery, including failure to reach recovery) and informing when mitigation or compliance actions are required.
- *Evidence-based decision-making frameworks*: Decision-making frameworks are critical to providing logical, transparent and reproducible support for ecological risk assessments, listing and development and implementation of recovery plans. The foundation of evidence-based decisions is the synthesis and critical appraisal of scientific evidence in relation to identified values or objectives. There are many enabling factors that increase the exchange of data and research into policy and practice, many of which would be relevant in facilitating improved outcomes for biodiversity. Participatory approaches, such as structured decision-making, can help navigate complex problems that require trade-offs by incorporating (and disaggregating) values and scientific data in decision-making and providing a framework to explore uncertainty and risk.
- *Decision support tools*: Decision-making frameworks need to be supported by decision support tools. Many of the world-leading conservation decision support tools have been developed in Australia, which can explicitly account for the environmental, social and economic benefits, costs and feasibility of actions, budget constraints and uncertainty. Two prioritisation examples include Marxan and Priority Threat Management, which help decision-makers quantify the risks and benefits of different development or management scenarios.

The National Environmental Science Program's Threatened Species Recovery Hub, the ARC Centre of Excellence for Environmental Decisions, the NCRIS environmental research infrastructure (the Terrestrial Ecosystems Research Network and and the Atlas of Living Australia) and the Centre for Deliberative Democracy and Global Governance have contributed immensely to each of these key areas of expertise. A developing NCRIS capability in environmental forecasting will also improve capabilities.

Solutions

1. A key part of improving the use of data is to develop and implement a data standard to define best-available evidence. A data standard outlines the quality, strength, certainty and relevance of the evidence required and clearly specifies how to incorporate uncertainty. Quality of scientific data can be assessed based on the study design (for example, systematic review, randomised controlled trial, Before-After-Control-Impact design, correlation or observation), sample size and use of appropriate methods to minimise bias.
    a. For decisions about Referrals and Controlled actions, the standard should be set in regulation and the precautionary principle automatically applied to prioritise

Matters of National Environmental Significance where the standard is not met. The standard should be relevant for data that supports all objectives (environmental, economic and social). This provides a quantitative and transparent justification for enacting the Precautionary Principle, highlighting data quality issues, and subsequently triggering the collection of more data prior to a decision to approve an action. The revised Act could establish a statutory scientific committee to provide specialist advice on environmental impact assessment and offsets and provide oversight on the implementation of this standard.

b. Data standards are also relevant in decisions relating to listing, implementation of management plans, monitoring and reporting. However, it would be more appropriate to specify data standards as a set of guidelines for these contexts. This is partly in recognition of the different data types used to support decision-making, including scientific data, expert opinion and traditional ecological knowledge. Quality of expert opinion can also be determined on the methods used to collect it (such as formal structured expert elicitation of a group of experts, opinions or experience of a single expert, or documented or verbal anecdotal evidence). However, if the primary purpose of the Act is to protect the environment, then decisions made in these circumstances should be precautionary, using the evidence available.

2. All data, including models and assumptions used to inform decisions under the Act, should be publicly available at the time a draft decision is released for comment. This is particularly pertinent for decisions about Referrals and Controlled actions (Table 1), and should include social, economic and environmental data. All environmental data— including the data on which environmental impact assessments are based— should be transparent, well documented, consistent in format and readily accessible by the public. Well informed decision-making relies on high-quality data systems.

3. Uncertainty should be specified for data underpinning all decisions made under the Act, in order to i) detect significant impacts or changes with confidence, ii) clearly demonstrate the potential consequences of different development options and iii) enable a clear analysis of trade-offs where decision-makers can utilise and demonstrate a consistent approach to risk.

4. The precautionary principle that underpins the EPBC Act should be maintained, given the potential consequences of poor environmental management. While a lack of information should not preclude all action, decisions should be made on the best available evidence for listing and implementation decisions (Table 1), accounting for uncertainty, with mechanisms for new evidence to affect regulatory decisions. To ensure confidence that environmental objectives are fundamental (prioritised) in planning decisions, the precautionary principle needs to be applied until data collected according to standards proves otherwise. For chronic, gradual declines, which occur across many threatened species and communities, this can be more challenging than is the case for abrupt, catastrophic events.

5. Data should be specifically linked to defined quantifiable thresholds that trigger decisions for action. This is relevant in many contexts, such as in a listing assessment, to support a change in action under a recovery plan, to trigger a referral, or the approval of a biodiversity offset. Uncertainty should be accounted for in these decision triggers, and a level of tolerance for uncertainty should be specified. Importantly, where decisions about Referrals and Controlled actions (Table 1) involve consideration of social and economic objectives, minimum impact thresholds need to be set for environmental objectives, such that the

environment can be set as a hard constraint[1] prior to any consideration of social and economic objectives. Trade-offs (weightings of objectives) should not be made under the Act until a minimum acceptable impact is specified.

6. Decisions that are made 'in the national interest' under the Act require clear definition and quantification (with uncertainty) of the competing interests or objectives, allowing for public scrutiny. Similarly, the underpinning data (whether economic, social or ecological) should be scrutinised in the same way.
7. Operations of the Act should be supported by clear best practice guidance (including decision support tools with worked examples and scenarios) to help decision-makers and managers navigate ecological risk assessments, listing, development proposals, biodiversity offsetting and implementation of recovery plans.

Outcomes

Many of the inefficiencies in the present system come from a lack of transparency and consistency in how assessments are performed. Integrating high-quality data and scientific advice will provide clarity and consistency, which will reduce the administrative burden. By ensuring decisions are justified or supported by the available data, the Precautionary Principle would be easier to adopt. Using decision support tools will facilitate evidence-informed decisions, can improve the outcomes for biodiversity and environmental values and better deliver the objectives of Act.

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[1] Specifying the environment as the primary object of the Act is also recommended (e.g. as per the Great Barrier Marine Park Act 1975), such that there is a clear justification for prioritising environmental over social and economic objectives.